DOCUMENT RESUME

ED 433 219 SE 062 507

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TITLE Resources for Teaching and Learning about Probability and Statistics. ERIC Digest.
INSTITUTION ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, OH.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO EDO-SE-99-08
PUB DATE 1999-05-00
NOTE 4p.
CONTRACT ED-99-CO-0024
AVAILABLE FROM ERIC Clearinghouse for Science, Mathematics, and Environmental Education, 1929 Kenny Road, Columbus, OH 43210-1080.
PUB TYPE ERIC Publications (071) -- ERIC Digests in Full Text (073)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Educational Resources; Elementary Secondary Education; Mathematics Activities; *Mathematics Instruction; *Probability; *Statistics; World Wide Web
IDENTIFIERS ERIC Digests

ABSTRACT

As increased use of technology and empirical science spreads throughout the global community, the use of data and graphs to communicate information increases also. This digest offers resources for teaching and learning about probability and statistics. It begins with key issues and continues with recommendations to overcome the difficulties in the teaching and learning of probability and statistics. It also provides an annotated listing of World Wide Web resources and materials introducing activities on probability and statistics. (ASK)

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As increased use of technology and the empirical sciences spreads throughout the global community, the use of data and graphs to communicate information is ever increasing. Daily decision making and discussions of social issues are increasingly influenced by statistics and projected outcomes based on estimated probabilities. Unfortunately, most high school graduates have little or no background in the mathematics associated with calculating probabilities and interpreting statistics. Therefore, in order for our students to be adequately prepared to make informed decisions, schools need to provide greater attention to probability and statistics in mathematics and other courses. Numerous educators (NCTM, 1989; NRC, 1989; Shaughnessy, 1992) have recommend the introduction of concepts related to probability and statistics throughout the school years for all students, not just those students bound for college.

Key Issues

In spite of increased support for teaching probability and statistics in schools, significant problems have been reported.

1. **Absence of probability and statistics lessons or courses in schools.** (Barnett, 1988; Shaughnessy, 1992): To date, very little probability and statistics have been taught in our schools.
2. **Teachers are not prepared to teach probability and statistics.** Historically, teacher preparation programs have not systematically included probability and statistics for prospective mathematics teachers (Shaughnessy, 1992).
3. **Student misconceptions and understanding.** Conditional probability and the notion of independent events are reported as particularly difficult concepts for students to grasp (Falk, 1988).
4. **Student beliefs and attitudes.** Statistics courses are some of the most rigorous and anxiety evoking for college students. Because of this, researchers have investigated techniques that may help to reduce anxiety and change negative attitudes experienced by students taking such courses (Sgoutas-Emch & Johnson, 1998).

Recomendations

Educators have been endeavoring to overcome the identified barriers to improving the teaching and learning of probability and statistics. Following are suggestions from researchers (Falk, 1988; Friel, 1998; Shaughnessy, 1992) who have studied the teaching and learning of concepts and applications of probability and statistics.

Regarding the school curriculum:

- Include a separate probability and statistics course in the main sequence of the mathematics courses.
- Promote increased awareness of the importance of probability and statistics in the curriculum.
- Confront students' and teachers' beliefs and concerns about probability and statistics.

Regarding teachers:

- Teachers must first confront their own misconceptions before they can be prepared to help students overcome misconceptions.
- Teachers must become familiar with students' preexisting conceptions related to probability and statistics before they try to teach the concepts.
- Learning statistics in elementary and middle schools involves building both conceptual and procedural knowledge.
- Teachers must use real world examples to help students understand concepts.
- Hands-on materials must be used in teaching and learning probability and statistics.
- Computer use of simulations enables students to investigate more realistic situations than were previously possible. This strategy is strongly supported by numerous studies.

Following is a listing of Internet and print resources for teaching and learning about probability and statistics.

World Wide Web Resources

Probability Computer Projects with Mathematica

http://www.wku.edu/~neal/probability/prob.html

Provides interesting problems occurring in probability. This page includes "Monte Carlo Approximation of Pi", "The Mystery of the Three Cards", "The Birthday Problem", "The Gambling Boundary Problem", and others.

The Probability WEB

http://www.maths.uq.oz.au/~pkp/probweb/probweb.html

Contains a collection of pages with the following headings: Probability links, Abstracts, Listservers, Newsgroups, People, Jobs, Journals, Software, Books, Conferences, Publishers and Miscellaneous.

Fun with Probability

http://lrs.ed.uiuc.edu/students/mcornell/cerealbox/index.html

Website for a cooperative classroom project for grades K-9. Students from five countries and 19 of the U. S. states participated in this project.

Three Door Puzzle

http://www.intergalact.com/threedoor/threedoor.html

Includes a simulation of the "Three Door Puzzle" of probability. Students can play an interactive game as often as they wish.

Classroom materials for teachers and students

http://forum.swarthmore.edu/probstat/probstat.lessons.html

Provides unit course materials and lesson plans, problems and puzzles, and reference materials.

Software for Probability and Statistics

http://forum.swarthmore.edu/probstat/probstat.software.html

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Contains publicly available software and online publishers for probability and statistics.

Internet project : Probability and Statistics

http://forum.swarthmore.edu/probstat/probstat.projects.html

Provides fun and challenging activities for students.

Materials Introducing Activities for Probability and Statistics Lesson

Freda, A. (1998). Roll the dice-an introduction to probability. *Mathematics Teaching in the Middle School, 4(2), pp. 85-89.*

A dice game that introduces students to probability is described. Two students roll the dice simultaneously and find the absolute value of the differences of the numbers that they get. Students then present explanations of what they found from this game.

Ruggles, J. & Slenger, B.S. (1998). The "measure me" doll. *Teaching Children Mathematics, 5(1), pp. 40-44.*

A unit of work that engages Kindergarten and first-grade students in making dolls to represent their birth statistics. The activities develop the children's emergent understanding of mathematics concepts.

Young, P. G. (1998). Probability, matrices, and bugs in trees. Teacher's guide and worksheets. *Mathematics Teacher, 91(5), pp. 402-406.*

Outlines activities that involve modeling the path of an insect between trees and determining the spread of the insect population in the trees. The activities involve the use of basic probability, simple random walks, matrices, and Markov chains.

Scavo, T. R. & Petraroja, B. (1998). Adventures in statistics. *Teaching Children Mathematics, 4, pp. 394-400.*

An activity on data analysis that engages fifth-grade students. The specific elements of the activity include a primary measurement task, data graphing, computation and interpretation of the average area, an analysis of area per student, and presentation of results.

Kader, G. & Perry, M. (1998). Push-penny: what is your expected score?. *Mathematics Teaching in the Middle School, 3, pp. 370-377.*

Outlines an activity that develops students' intuitive feeling for the consequences of randomness. In addition to having the central statistical principle, the law of large numbers, and probability distribution illustrated for students, this activity enables students to develop their data handling skills and their skills in constructing and using tables and graphs.

Greeley, N. & Offerman, T. R. (1998). Words, words, words; ancient communication. *Mathematics Teaching in the Middle School, 3, pp. 358-364.*

Three activities that are based on newspaper articles are outlined: "Frequencies", "Making the Words Fit", and "Check Out That Fog" activities. These activities can be given to students for independent study, and each involves analyzing newspaper articles for their clarity.

Perry, M. & Kader, G. (1998). Counting penguins. *Mathematics Teacher, 91, pp. 110-116.*

An activity based on counting penguins is outlined. It can be used to illustrate the nature of sampling variability, the effect of sample size on the quality of estimation, and the role of the underlying population distribution.

Robinson, P. (1997). Probability, mortality and life assurance. *Mathematics in School, 26, pp. 42-45.*

This activity involves generating expected values or probability values, and present values, as well as applying discount factors and using mortality tables.

Brunner, R. B. (1997). Numbers, please! The telephone directory and probability. *Mathematics Teacher, 90, pp. 704-705.*

This paper illustrates how students can use the telephone directory in collaborative group assignments in their introductory probability and statistics class to help them understand such concepts as Monte Carlo simulations.

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SE 062 507

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EDO-SE-99-08

This digest was produced with funding provided by the U.S. Department of Education under contract no. ED-99-CO-0024. Opinions expressed in this digest do not necessarily reflect the positions or policies of the Department of Education.

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